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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project	Date	Author

TITLE

STUDY OF ACCURACY AND RESULTS OF RISK MARKINGS BLACK'S MOUNTAIN EXPERIMENTAL FOREST

Season 1939

A Progress Report

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JEP
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STC
FCJ
ESG

by
J. W. Bongberg
Berkeley, California
April 5, 1940

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BLACK'S MOUNTAIN EXPERIMENTAL FOREST

Season 1939

A Progress Report

INTRODUCTION

The sustained yield experiment in pine on the Black's Mountain Experimental Forest calls for a preliminary light cut over the entire area to remove high risk trees. In cooperation with the California Forest and Range Experiment Station, the U. S. Bureau of Entomology and Plant Quarantine is marking the high risk trees for removal, determining the degree of loss reduction secured by cutting, following the infestation trends on both cut and uncut areas, and studying a number of miscellaneous phases of the project connected with the broad objectives of the Bureau program.

This report has been prepared to record progress made during the 1939 season on various phases of the project not reported upon in previous progress reports. Much of the work is a continuation of studies started during 1937 and 1938.

OBJECTIVES OF THE BUREAU PROGRAM

The broad objectives of the Bureau of Entomology and Plant Quarantine in the Black's Mountain Experiment are:

1. Is it possible to detect high risk trees in an undisturbed green stand with a high degree of accuracy?

2. Will the removal of high risk trees in a sanitation-salvage cutting program materially reduce subsequent insect loss resulting from endemic infestations?

3. Will the removal of high risk trees from the stand help prevent the occurrence of conditions contributing to the build up of heavy western pine beetle populations?

In tests designed to answer these objectives it was necessary first to develop ratings of risk which could be applied to the green stand. Secondly a comparison of losses on areas treated in the sanitation-salvage cutting program with undisturbed check areas would indicate the degree of loss reduction secured by cutting. Thirdly, by recording losses on treated areas for a period of years it would be possible to determine the effect of cutting in the prevention of barkbeetle outbreaks.

TESTS OF RISK RATINGS AT BLACK'S MOUNTAIN

1. Development of Risk Ratings

Briefly, the characters used in defining risk makes use of the apparent health of the crown as evidenced in the foliage, twigs, and branches. Ratings of risk that have been used at Black's Mountain were first developed on research plots in the Modoc and Lassen National Forests. These ratings have been tentatively described by Dr. K. A. Salman in a Station memorandum dated March 28, 1940, "Descriptions of Risk Ratings for Ponderosa and Jeffrey Pines in Eastside Forest Areas of California". In addition to the risk ratings, both Dunning's and Keen's tree classifications were applied to each tree. The risk ratings are the basis being used to select trees for the sanitation-salvage cut where only those trees expected to die in the near future are being removed.

2. Risk Marking

Tests designed to determine the possibility of detecting high risk trees with a high degree of accuracy involves the marking of risk to individual trees. The area covered in applying risk during the past three seasons is shown in figure 1. The proportion of the green stand in each of the four risk groups is summarized in table 1.

Table 1.

Distribution of Green Stand by Risk Groups.

Year of Marking	Timbered Acreage	RISK I. (% Total)		RISK II. (% Total)		RISK III. (% Total)		RISK IV. (% Total)	
		Trees	Vol.	Trees	Vol.	Trees	Vol.	Trees	Vol.
1937	939.0	71.7	60.6	18.1	24.8	5.8	8.2	4.4	6.4
1938	513.0	60.2	49.3	27.8	34.2	7.9	10.6	4.1	5.9
1939	1034.0	65 1	51.7	24.0	32.9	6.3	9.1	4.6	6.3
Total	2486.0								
Aver.		66.8	54.8	22.3	29.9	6.4	9.0	4.4	6.3

The occurrence of loss in each risk group has been recorded at periodic intervals since risk ratings were first applied. These records have shown that 83 percent of the loss has occurred in 12 percent of the stand originally classed as high risk. (Page 3, "Insect Loss Survey, B.M.E.F. Season 1939, Station Report of J. W. Bongberg, Berkeley, California, January 12, 1940.) This indicates a high degree of accuracy in detecting high-risk trees in an undisturbed green stand.

3. Change in Risk

It is to be expected that during a period of years, the health or relative risk of individual trees will change. A majority of the mature and overmature trees now rated as moderate risk might be expected to gradually change to high risk. It is not impossible however that trees of moderate risk will show recovery and return to the low-risk group.

A quantitative measurement of change in risk can be secured by making periodic loss surveys on areas where indelible risk markings have been applied to all trees. By recording the seasonal loss occurrence in each risk group on these marked areas it will be possible to prepare curves showing changes in loss by risk groups over the number or years represented in the record. At present sufficient data is not available to prepare such curves. At least five years of records will be necessary before we can draw more than tentative conclusions concerning this quantitative measurement.

Qualitative measurements of changes in risk can be secured by making detailed measurements of critical crown characters on individual trees. This procedure was started at Black's Mountain during 1938. Detailed crown characters were recorded on 1,900 trees on 100 acres of plots. Eighty acres of these plots were established by the Experiment Station to demonstrate methods of cutting and were purposely selected in this study to determine the risk change in individual trees following cutting.

During the past season the study was enlarged to cover the six 20-acre method of cutting plots which were established in 1939. In addition, a 10-acre undisturbed plot was established in each of the five natural areas to insure isolation from the influence of nearby cutting operations. In all, 3,814 trees are now being observed to study change in risk. Changes in risk that have been recorded during a one-year period on all check plots established during 1938 are shown in the following table:

Table 2.

Change in Risk for a One-Year Period. (Check Plots)

	RISK GROUP I.				RISK GROUP II.			
	1st Marking (1938)		2nd Marking (1939)		1st Marking (1938)		2nd Marking (1939)	
Risk	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent
I.	241	100.0	198	82.2			38	20.8
II.			40	16.6	183	100.0	114	62.3
III.			3	1.2			24	13.1
IV.			0	0.0			7	3.8
Death			0	0.0			0	0.0
Total	241	100.0	241	100.0	183	100.0	183	100.0

Table 2. (Continued)

	RISK GROUP III.				RISK GROUP IV.			
	1st Marking (1938)		2nd Marking (1939)		1st Marking (1938)		2nd Marking (1939)	
Risk	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent
I.								
II.			12	22.2				
III.	54	100.0	23	42.6				
IV.			19	35.2	25	100.0	24	96.0
Death			0	0.0			1	4.0
Total	54	100.0	54	100.0	25	100.0	25	100.0

Table 2 would indicate that there has been considerable change in three of the four risk groups during a one-year period. It is felt however that a majority of the risk changes in group I was brought about by a more strict observance of crown characters. Changes in risk II may be responsible for a decrease in judging the importance of a scattering of dead twigs and branches throughout the crown. The apparent recovery of a portion of risk group III may be the result of border line trees originally placed in that group. With few exceptions, the changes in risk which were recorded were in the mature and overmature trees. As indicated in the table, only one tree in a total sample of 503 died during this past season. This tree had been placed in risk group IV prior to death.

Table 3.

Change in Risk. Areas Treated by Sanitation-Salvage Cutting. One-Year Period.

	RISK GROUP I.				RISK GROUP II.			
	1st Marking (1938)		2nd Marking (1939)		1st Marking (1938)		2nd Marking (1939)	
Risk	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent
I.	616	100.0	517	83.9			73	28.1
II.			91	14.8	260	100.0	155	59.6
III.			8	1.3			26	10.0
IV.			0	0.0			5	1.9
Death			0	0.0			1	0.4
Total	616	100.0	616	100.0	260	100.0	260	100.0

	RISK GROUP III.				RISK GROUP IV.			
Risk								
I.								
II.			3	18.8				
III.	16	100.0	10	62.4				
IV			3	18.8	2	100.0	2	100.0
Death			0	0.0			0	0.0
Total	16	100.0	16	100.0	2	100.0	2	100.0

In table 3, which records changes in risk on plots subjected to sanitation salvage treatment, the first thing noticed is the occurrence of trees in risk groups III and IV. This occurrence is a result of rating risk on one 20-acre plot 14 months after the initial sanitation-salvage program. Changes in risk however are based on ratings applied in 1938 when detailed crown characters were recorded. A comparison of tables 2 and 3 shows less change in risk on areas treated in the sanitation-salvage program. In contrast to table 2, the apparent recovery of 28 percent of the risk II trees may be the result of release through cutting rather than an interpretation of importance of scattered dead twigs and branches in portions of the crown. Additional seasons observations will be necessary to draw conclusions from this indication. A single risk II tree of the 894 tree sample died during this one-year period.

Table 4.

Change in Risk. Modified Forest Service Cutting. One-Year Period.

	RISK GROUP I.				RISK GROUP II.			
	1st Marking (1938)		2nd Marking (1939)		1st Marking (1938)		2nd Marking (1939)	
Risk	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent
I.	229	100.0	222	96.9			14	34.1
II.			7	3.1	41	100.0	25	61.0
III.			0	0.0			2	4.9
IV.			0	0.0			0	0.0
Death			0	0.0			0	0.0
Total	229	100.0	229	100.0	41	100.0	41	100.0

	RISK GROUP III.				RISK GROUP IV.			
Risk								
I.								
II.								
III.	0	0.0	0	0.0				
IV.					0	0.0	0	0.0
Death								
Total	0	0.0	0	0.0	0	0 0	0	0.0

Under the Modified Forest Service cutting, the reversal of 14 trees from risk II to risk I may be the result of less severe appraisals of risk II trees during the second year's examination. However, here, as in table 3, the recovery of the risk II trees may be the result of release through cutting.

Table 5.

Change in Risk on Standard Forest Service Cutting Plot. One-Year Period.

	RISK GROUP I.				RISK GROUP II.			
	1st Marking (1938)		2nd Marking (1939)		1st Marking (1938)		2nd Marking (1939)	
Risk	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent	No of Trees	Percent
I.	160	100.0	136	85.0			3	8.1
II.			23	14.4	37	100.0	28	75.7
III.			1	0.6			5	13.5
IV.			0	0.0			1	2.7
Death			0	0.0			0	0.0
Total	160	100.0	160	100.0	37	100.0	37	100.0

	RISK GROUP III.				RISK GROUP IV.			
Risk								
I.								
II.			1	16.7				
III.	6	100.0	3	50.0				
IV.			2	33.3	2	100.0	2	100.0
Death			0	0.0			0	0.0
Total	6	100.0	6	100.0	2	100.0	2	100.0

Changes in risk as indicated in table 5 are not more than would be expected during a one-year period.

FACTORS AFFECTING CHANGES IN RISK

1. Effect of D. valens

During the periodic insect loss cruises on areas treated in the sanitation-salvage cutting program, a few trees previously rated as low risk were found to have been attacked by barkbeetles following the logging program. In some cases where trees grew close together and one had been cut, it was felt that the attacks of the red turpentine beetle in the green stump had overflowed and attacked the basal portion of the bole of the remaining green tree. This attack may have weakened the green tree to a point where more primary barkbeetles had been attracted. It seemed advisable to make sufficient observations on paired trees where one tree had been cut and the other left standing to determine if the attractive qualities of the green stump to adults of the turpentine beetle would be sufficient to start an infestation in the green tree remaining. Providing that the red turpentine beetle was the responsible agent in weakening a few trees previously classed as low risk, death would supposedly be occurring in low-risk trees because the trees had become attractive through attacks by D. valens.

During 1939 approximately 75 pairs of trees standing within a basal radius of 10 feet, one of which had been cut and the other left standing, were selected for periodic observations of D. valens activity. Thirty-five pairs of check trees were established outside the cut areas. No results have been secured to date on the influence of turpentine beetle attacks leading to infestation by barkbeetles. Continued studies will be necessary to determine this point.

2. Effect of Top-killing Infestations

During 1939 a considerable "flare up" of top-killing engraver beetle damage was noticed throughout the experimental area. Because of this top-killing activity it was decided to make detailed studies to determine the relation of top-killing on risk change and death. The season's study was concentrated on the 10-acre plots in the natural areas and on the control plots in the series demonstrating methods of cutting. During 1939, 166 trees were carefully measured for extent of top-killing. Periodic observations during the next few seasons should indicate the relation of top-killing on risk change and death.

3. Effect of Scale Insects

One tree just being attacked by the western pine beetle during the fall of 1939 had been rated as a risk 1 in 1937. At the time of attack by the pine beetle the tree was definitely a high-risk type. An analysis of the bole of this tree failed to reveal any insect in the cambium region which could have been responsible for the poor health of the tree. As a result, samples of twigs and branches were thoroughly examined for scale insects. These samples revealed a number of Matsucoccus sps. present (Memorandum for Files. "Notes on Experimental Ponderosa Pine Tree at Hall's Flat." by H. L. McKenzie. Berkeley, California, October 19, 1939). In this one example, scale insects were apparently responsible for a change from risk I. to risk IV. in a 26-month period. To prove this would have required some study of the scale population in 1937 and a better knowledge of the injury produced by the scale.

IMMUNITY VERSUS RISK

It is the opinion of the writer that very few trees in the east side pine stands are immune to attacks by the western pine beetle. This is true at least as far as mature and overmature trees are concerned. Providing conditions are favorable, attacking adults could very well produce successful broods in many or all of the trees, regardless of the degree of risk. The successful attacks on trees considered as low risk was well demonstrated during 1939 as pine beetle activity increased throughout the area. However, as will be pointed out in the following paragraph, barkbeetles do not normally select low risk trees for attack.

As barkbeetle activity increases, losses tend to occur in groups of two or more trees. This group kill is apparently a result of large populations of attacking adults being attracted to an individual tree, generally a high-risk type, and as this tree becomes completely infested, the adults continue to be attracted to the vicinity and attack one or more trees nearby. It is from these observations that the assumption is made that there is little difference in immunity between trees, whether these trees have been rated as low or high risk. The difference does not seem to be in the relative immunity of trees but the relative risk or attractiveness of trees. Much of the loss in the low-risk groups (table 2, page 3 "Insect Loss Survey. Black's Mountain Experimental Forest". Season 1939. Station Report by J. W. Bongberg. Berkeley, California. January 12, 1940.) resulted because an overflow of beetles attracted to a high-risk tree continued to attack other nearby trees previously rated as low risk. Reference to this point will be made later when discussing tentative conclusions in regard to the third objective listed on page 1.

TESTS OF CUTTING METHODS IN REDUCTION OF INSECT LOSS

1. Sanitation-Salvage Cutting

The effect of sanitation-salvage treatment on reduction of insect loss has been measured by comparing loss records on cut and uncut areas. These records have shown that loss reduction by sanitation salvage treatment for one and two-year periods has ranged from 86 to 90 percent (Table 4, page 4, "Insect Loss Survey. B.M.E.F." Season 1939. Station Report by J. W. Bongberg. Berkeley, California. January 12, 1940).

Progress of cutting, inclusive of the Experiment Station's series of demonstration plots is shown in figure 2. An inventory of the sanitation-salvage cutting is given in table 6.

Table 6.

Inventory of Sanitation-Salvage Cutting

Year of Cutting	Timbered Area Cut	INVENTORY OF REMOVAL: Low Risk Trees	Low Risk Volume	High Risk Trees	High Risk Volume	Total Trees	Total Volume	Vol./Acre.
1937	243.0	123	191,368	411	497,252	534	688,620	2,834
1938	288.4	1	736	849	875,166	850	875,902	3,037
1939	609.0	76	148,724	1,179	1606,735	1,255	1755,459	2,883
Total	1,140.0	200	340,828	2,439	2979,153	2,639	3319,981	
Average								2,911

2. Demonstration Plots in Methods-of-Cutting

During 1938 the Experiment Station established four 20-acre plots to demonstrate methods of cutting ("Plans for Methods-of-Cutting Study. Black's Mountain Sustained Yield Project". Ms Report. CF&RES. by A. A. Hasel. Berkeley, California. May 6, 1938.).

(1) Modified Forest Service Cutting (M.F.S.): All trees 18" d.b.h. and over which could be classed either as high risk or in Dunning's classes 4, 5, or 7 are cut. All low-risk trees of Dunning's classes 1, 2, 3, or 6 are left. Class 5A trees, distinguished from class 5 by having long crowns, are left, except those having one or two grade 1 butt logs. The reserve stand will not be cut for a period of 30 years.

(2) Silvicultural-Selection Cutting (S.S.): All trees classed as high risk will be cut first Future salvage cuts will be made if the volume in high-risk trees again approaches 2,500 board feet per acre before utilization cuts have been made. Following this first cut, a heavy cut will be made where reproduction is satisfactorily established. Where brush dominates reproduction or where reproduction is not well established, a series of light cuts will be made. These cuts will be timed when seed crops are ripe in order to make conditions favorable for securing and liberating reproduction. After a series of cuts over a 10 - 12 year period, the residual stand will approximate that of the Standard Forest Service cut.

(3) Standard Forest Service Cut (F.S.): Approximately 50% of the total green volume is cut. The reserve stand is made up primarily of trees in Dunning's classes 1, 2, and 6. In addition, the best trees in classes 3 and 4 are left. The majority of the trees in 4, 5, and 7 are cut. No additional cutting will be done for 60 years.

(4) Control Plot (C): This plot has been set aside to serve as a check against cutting practice on the other plots.

Insect losses that have occurred in the reserve stand on these plots and isolation strips for the one-year period following treatment are shown in table 7.

Table 7.

Insect Losses on Methods of Cutting Plots. B. M. E. F.
(One-Year Period. Pine Only)

Block No.	Plot No.	Timbered Area	Method of Cutting*	Cutting (% Stand) Trees	Cutting (% Stand) Vol.	INSECT LOSS No. of Trees	INSECT LOSS Volume B. M.	INSECT LOSS (% Residual Stand) Trees	INSECT LOSS (% Residual Stand) Volume
'38	1	31.9	M.F.S.	32.4	49.3	-	-	-	-
'38	2	30.5	Control	-	-	6	8,984	1.0	1.4
'38	3	32.1	S.S.	11.5	8.8	1	234	0.2	0.1
'38	4	33.3	F.S.	55.9	75.1	-	-	-	-

* Abbreviations denote methods of cutting previously described.

The series of experimental plots established by the Experiment Station during 1939 is a continuation of the study started in 1938. Two additional plots were included in the 1939 work, one to demonstrate clear cutting (C C.) and another for sanitation-salvage cutting without a return for heavier silvicultural cuts (I.S.). An inventory of cutting and reserve stand on each plot in the 1939 series is given in table 8.

Table 8.

Inventory of Cutting and Reserve Stand on Demonstration Cutting Plots. (Block '39)

Block No.	Plot No.	Timbered Area	Method of Cutting*	INVENTORY OF CUTTING (Low Risk) Trees	Volume	(High Risk) Trees	Volume	INVENTORY OF RESERVE (Low Risk) Trees	Volume	(High Risk) Trees	Volume
'39	1	32.0	I.S.	-	-	55	86,865	430	411,531	-	-
'39	2	33.5	S.S.	20	38,348	42	66,201	289	392,835	-	-
'39	3	31.0	M.F.S.	132	241,028	46	83,641	226	190,688	4	1,501
'39	4	31.0	C.C.	301	405,318	37	70,785	107	17,630	-	-
'39	5	29.2	Control	-	-	-	-	341	404,117	32	49,113
'39	6	29.0	F.S.	320	401,198	64	68,242	231	107,627	3	414

* Abbreviations denote methods of cutting previously described.

OBSERVATIONS ON LOSS OCCURRENCE

A record of losses on treated areas for a period of years will indicate the effectiveness of sanitation-salvage treatment as a measure in preventing conditions contributing to a build-up of heavy pine beetle populations. Only two years of records are available for tentative conclusions to this objective.

During 1939, losses on virgin areas within the Experimental Forest showed an increase of approximately 123 percent over the 1938 loss. Group kills of two and more trees were frequent throughout the uncut areas. In contrast to this, only a small amount of loss occurred on areas where all high-risk trees had been removed. In addition, there was very little variation in amount or type of loss in treated areas during the two seasons. Practically all infested trees occurred singly with only two groups of but two trees each found on the 531 acres treated during 1937 and 1938.

Referring now to the writer's opinion of immunity versus risk. From a comparison of 1938 and 1939 loss records on cut and uncut areas, it can be tentatively stated that the removal of high-risk trees has helped prevent the occurrence of conditions contributing to the build-up of heavy pine beetle populations during these two seasons. On areas where high-risk trees have been removed, the "attraction" for attacking adults has apparently been lessened and conditions do not appear to favor an increase in pine beetle populations. The rate in which low-risk trees change to high risk will probably influence the conditions favoring a population increase.

Additional records covering periods representing both epidemic and endemic loss conditions are necessary to definitely indicate the value of sanitation-salvage treatment in providing lasting protection to the reserve stand.

PLANS FOR CONTINUING WORK DURING 1940

All phases of the entomological work directly connected with the Black's Mountain project will be continued during 1940.

1. It will be necessary to mark high-risk trees for removal over all areas to be cut during the coming season.

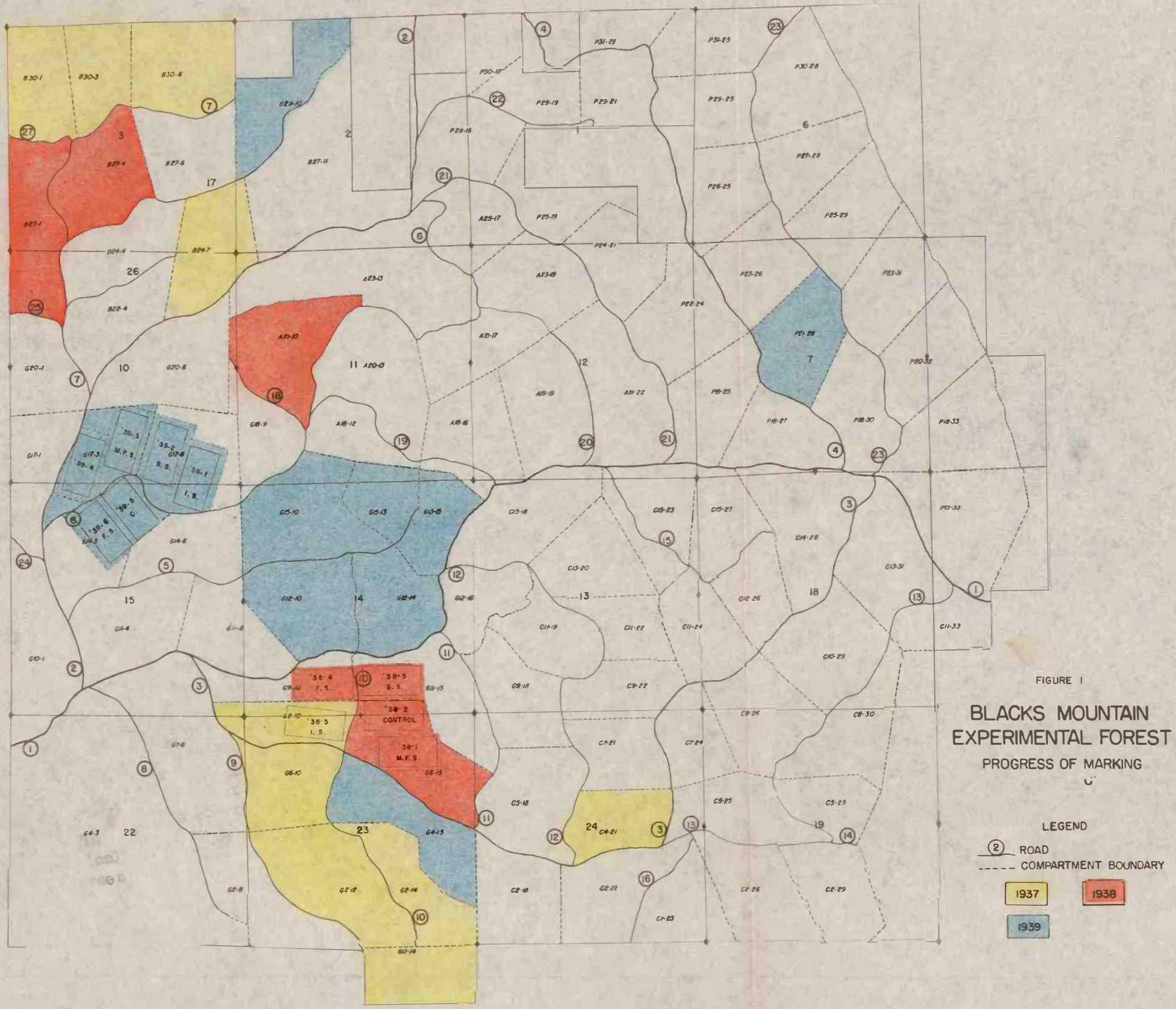
2. To determine the length of time risk ratings will remain valid on various areas, it is planned to make detailed crown measurements on trees in other hazard zones than those represented at Black's Mountain.

3. A re-measurement of crown characters will be made on each of the 3,800 trees now established for determing rate of risk change.

4. Periodic observations will be continued on D. valens activity to determine the effect of attacks by this beetle in making trees on cut areas attractive to other primary barkbeetles.

5. Top-killing activity will be studied in detail to determine the relation of top-killing on risk change and death.

6. On cutover areas, infested trees should be felled to determine infestation types for comparison with the infestation on virgin areas. This work should be done during the early spring months before overwintering broods emerge.


'38-4 F. S.
'38-5 S. S.
'38-2 CONTROL
'38-5 I. S.
'38-1 M.F.S.
'39-1 I. S.
'39-2 S. S.
'39-3 M.F.S.
'39-4
'39-5 C.
'38-6 F. S.
'39-6
FIGURE 1
BLACKS MOUNTAIN EXPERIMENTAL FOREST
PROGRESS OF MARKING
LEGEND
ROAD
COMPARTMENT BOUNDARY
1937
1938
1939

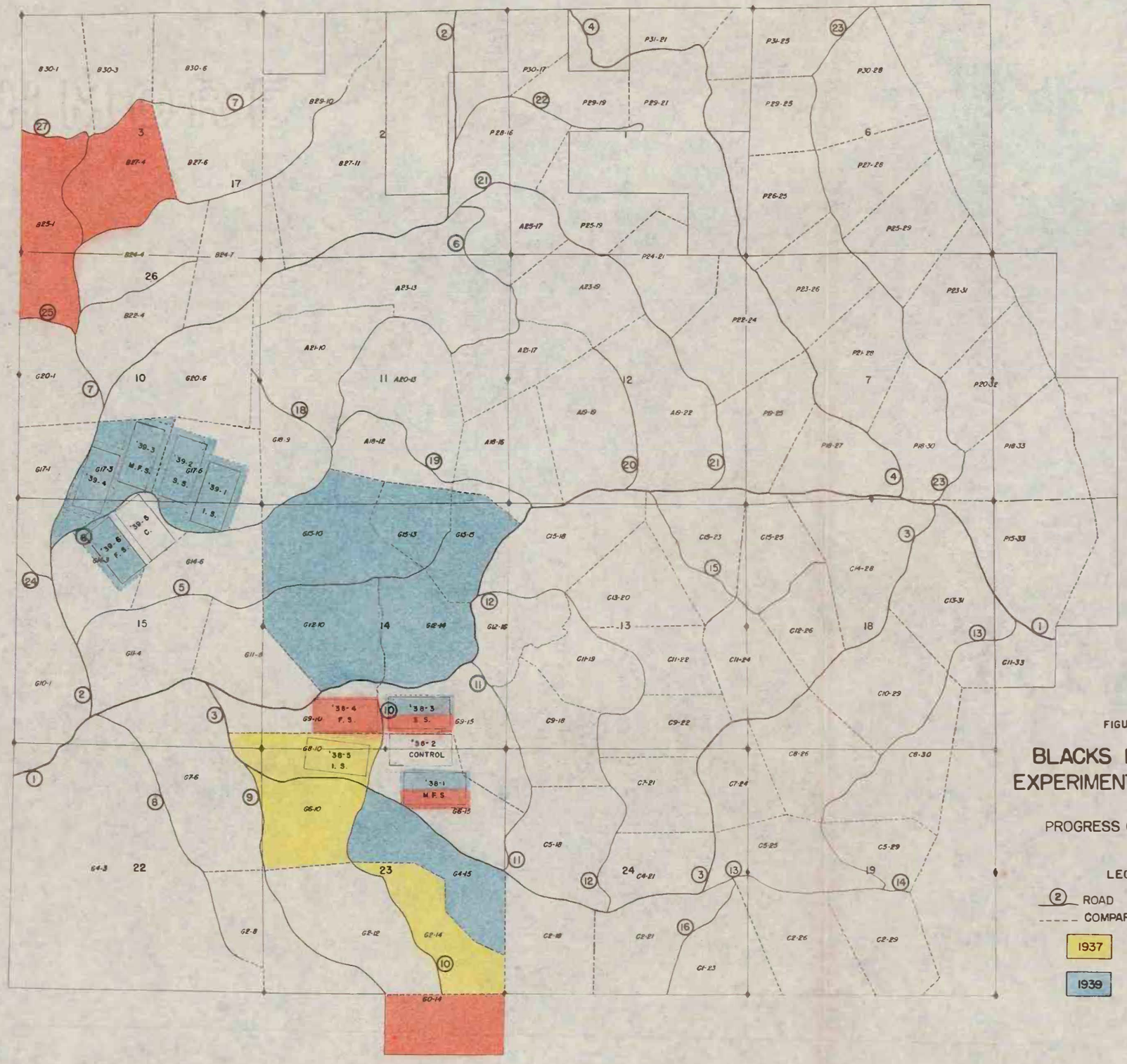


FIGURE 2

BLACKS MOUNTAIN EXPERIMENTAL FOREST

PROGRESS OF CUTTING

LEGEND

ROAD

COMPARTMENT BOUNDARY

1937

1938

1939